

Patent Claims

1. Method for calibrating an ultrasonic flow measuring device (1),
5 which includes a measuring tube (2), at least two ultrasonic
sensors (3, 4; 5, 6) and a control/evaluation unit (17), wherein
the ultrasonic sensors (3, 4; 5, 6) emit and/or receive
ultrasonic measuring signals, wherein the flow of a medium in the
measuring tube (2) is determined on the basis of the travel times
10 of the ultrasonic measuring signals, which traverse the measuring
tube (2) in the stream direction (S) and counter to the stream
direction (S),
wherein information concerning the theoretical flow of the medium
through the measuring tube (2) is won on the basis of
15 predetermined, geometric, production data of the flow measuring
device (1),
wherein actual, geometric measurement data of the flow measuring
device (1) is determined three-dimensionally,
wherein information concerning the actual flow of the medium
20 through the flow measuring device (1) is won on the basis of the
actual, geometric measurement data, and
wherein a correction, or calibration, factor is determined for
the flow measuring device (1) on the basis of the information
concerning the theoretical flow, and the actual flow, of the
25 medium through the flow measuring device (1).

2. Method as claimed in claim 1,
wherein the actual, geometric measurement data is determined by a
three-dimensional scanning of the flow measuring device (1).

3. Method as claimed in claim 2,
wherein the scanning of the flow measuring device (1) is
performed by means of electromagnetic waves or by means of a
mechanical scanning head (16).

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4. Method as claimed in claim 2 or 3,
wherein the flow measuring device (1), or the measuring tube (2),
is simulated by a mathematical model.

10 5. Method as claimed in claim 4
wherein, in the mathematical model, the following variables are
taken into consideration:

- the angle of incidence and/or angle of emergence between
ultrasonic sensor (3, 4; 5, 6) and the medium;
- 15 - the separation (S_1 ; S_2) between two sound emitting,
respectively two sound receiving, surfaces of the ultrasonic
sensors (3, 4; 5, 6), which alternately emit and receive;
- the radial separation H of the sound paths of the ultrasonic
measuring signals of two ultrasonic transducers (3, 4; 5, 6)
20 about the central axis of the measuring tube (2);
- the positions of the emitting and receiving surfaces of the
ultrasonic sensors (3, 4; 5, 6) relative to the flowing
medium or to the inner wall of the measuring tube;
- the cross sectional area A of the section of the measuring
25 tube (2) lying between the two ultrasonic transducers (3, 4;
5, 6) and flowed-through by the medium.

6. Method as claimed in claim 2 or 3,
wherein the actual inner cross sectional area of the measuring
30 tube (2) is determined by measuring the three-dimensional
coordinates of a plurality of scanning points lying in at least

two parallel cross sectional planes (9, 10) of the measuring tube transverse to the stream direction (S) of the medium.

7. Method as claimed in claim 2 or 3 or 5,

5 wherein the three-dimensional coordinates of the sound emergence, respectively sound incidence, surfaces of the ultrasonic sensors (3, 4; 5, 6) are determined.

8. Method as claimed in claim 7,

10 wherein, for the purpose of determining the three-dimensional coordinates of the midpoint of the sound emergence, or sound incidence, surface of an ultrasonic sensor (3, 4; 5, 6), a setup gage (13, 15) is used, in which, instead of an ultrasonic transducer, a cone (14) of defined shape is used, which is so
15 embodied, that the midpoint of a ball (16) of defined diameter lies in the midpoint of the sound emergence, or sound incidence, surface of the corresponding ultrasonic sensor (3, 4; 5, 6), when the ball (16) contacts the cone (14).

20 9. Setup gage (13, 15) for performing a method as claimed in one or more of the claims 1 to 8,

wherein, instead of the ultrasonic transducer, a cone-shaped element (14) is used, which is so dimensioned, that the midpoint of a ball (16), whose diameter corresponds to the diameter of a
25 scanning head of a mechanical scanning device, lies in the midpoint of the sound emergence, or sound incidence, surface of the ultrasonic sensor (3, 4; 5, 6), when the ball (16) contacts the cone-shaped element (14).

10. Setup gage (13, 15) for carrying-out the method as claimed in one or more of the claims 1 to 8, wherein, instead of the ultrasonic transducer, a retroreflector element is provided, which is so embodied, that impinging
5 electromagnetic radiation from a scanning device is reflected back, into the scanning device.